

The vascular flora of Empoli (Tuscany, central Italy)

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Abstract

A list of the vascular flora occurring in the municipality of Empoli (province of Firenze, Tuscany) is provided. The list is based on a bibliographic analysis and on field studies carried out in the years 2018–2022. A total of 757 specific and subspecific taxa currently occur in the study area (including 117 aliens), plus 51 cultivated taxa. *Azolla filiculoides* Lam., *Prunus cerasifera* Ehrh., and *Veronica filiformis* Sm. should be considered as naturalized aliens in Tuscany.

Keywords

alien species, biodiversity, endemics, floristic data, Italy, phytogeography, Tuscany

Introduction

A flora is a useful source of information for biogeographical, ecological, and evolutionary studies (D’Antraccoli et al. 2022b). For these reasons, a satisfactory floristic knowledge of a territory is crucial for many other applications in plant science (Peruzzi 2018). In floristic studies, it is very important to have a ‘starting hypothesis’ concerning the number of taxa expected in a study area. To achieve this, Species-Area Relationships (SARs) are an excellent tool (D’Antraccoli et al. 2019). In addition, since no floristic study can be considered to be exhaustive (D’Antraccoli et al. 2020), a Map of Relative Floristic Ignorance and a Virtual Floristic List (D’Antraccoli et al. 2022a) are also useful to plan future floristic research in the study area. With these tools, one can represent the spatial distribution of the lack of floristic knowledge and obtain a list of taxa potentially occurring in the area with an associated probability of occurrence.

The territory in the municipality of Empoli (Tuscany, central Italy; Fig. 1) was hitherto never studied by botanists. Between 1860 and 2003, only 26 floristic records are available (Caruel 1860; Baroni 1897–1908; Fiori 1943; Pignotti 2003; Arrigoni 2018). More recently, Peruzzi (2021) presented a first draft of a flora in a popular book, listing 672 taxa.

The aim of this study is to present a complete and updated floristic inventory of the vascular flora of Empoli, in the framework of a series of contributions whose goal is to improve the floristic knowledge of Tuscany (Pierini et al. 2008; Peruzzi et al. 2011; Gestri and Peruzzi 2012, 2013, 2014; Ciccarelli et al. 2015; Gei et al. 2016; Pierini and Peruzzi 2014; Roma-Marzio et al. 2016; Carta et al. 2018; Roma-Marzio et al. 2020).

Material and methods

Study area

The municipality of Empoli (province of Firenze) lies at an elevation between 22 and 205 m a.s.l., and covers an area of 62.28 km². The Arno river constitutes its northern administrative limit, while the western limit is the Elsa river. Less obvious are the eastern and southern limits, with the municipalities of Montelupo Fiorentino, Montespertoli, and Castelfiorentino. From a geological point of view, the hills are made by middle Pliocenic and Pleistocenic sediments (clays, conglomerates, sands), while the plain by Holocenic alluvial sediments (Ghezzi and Ghezzi 1998).

The hills have a temperate bioclimate and belong to the preapenninic neutroba-siphilous Turkey oak vegetation series of central and northern Italy (*Lonicero xylostei-Quercus pubescentis sigmetum*), while the plain shows a temperate transition towards a Mediterranean bioclimate, belonging to the hygrophilous geosigmetum of the riparian vegetation of the Italian peninsula (*Salicion albae*, *Populion albae*, *Alno-Ulmion*) (De Dominicis et al. 2010a, 2010b). Concerning the actual land use, most of the territory is cultivated, mainly with olive orchards (*Olea europaea* L.) and vineyards (*Vitis vinifera* L.). The overbuilding rate is 18% (Munafò 2020), and the spontaneous vegetation is restricted to a few relictual sites, among which a small forest area well visible in Fig. 1. This is not particularly surprising, given that Empoli experienced a growing urbanization since 1119. Starting from the 16th century, the original courses of the Arno and Elsa rivers were modified, by cutting some of their meanders (Lastraioli 2014). Moreover, the human presence has been continuous in the last 100,000 years (Pagli 2019).

Methods

Besides the analysis of the few literature sources available (see Introduction), field investigations were carried out in the last 20 years, more intensively in the years 2018–2022. The most interesting findings were published during the course of this research (Peruzzi 2004, 2014; Peruzzi et al. 2007; Atzori et al. 2008; Peruzzi et al. 2017, 2018,

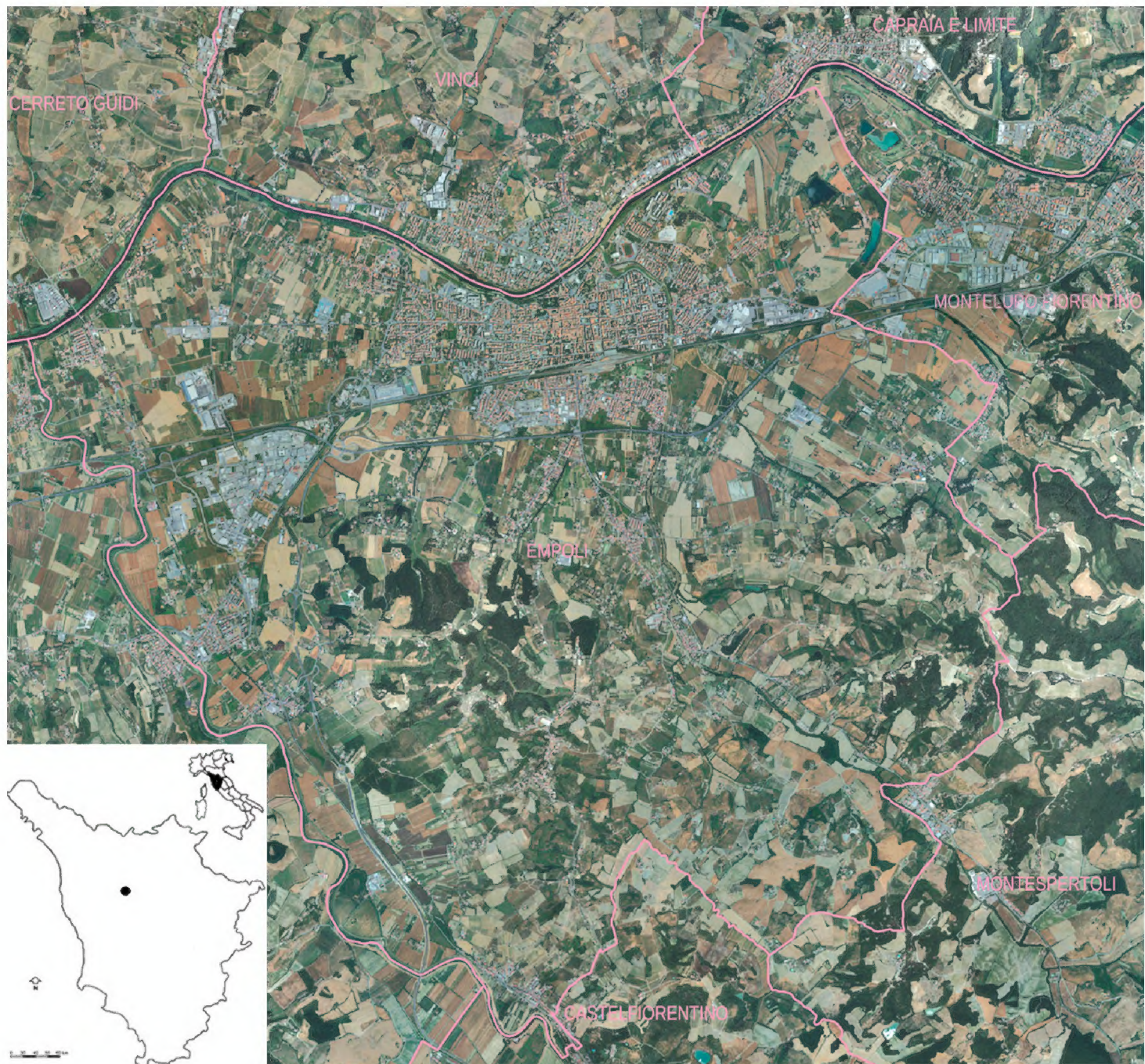


Figure 1. Localisation and delimitation of the municipality of Empoli (province of Firenze, Tuscany, central Italy). The dominance of cultivated and urbanized areas is evident. The image (2019 AGEA orthophoto) was obtained by means of Cartoteca del Geoscopio della Regione Toscana (<http://www502.regione.toscana.it/geoscopio/cartoteca.html>).

2019, 2020, 2021, 2022; Roma-Marzio et al. 2018; Bartolucci et al. 2021, 2022). These data were complemented by field observations, which have been stored in Wikiplantase #Toscana (Peruzzi and Bedini 2013 onwards).

Nomenclature and circumscription of the taxa follows Bartolucci et al. (2018), Galasso et al. (2018) and their updates periodically appearing in the Portal to the Flora of Italy (<https://dryades.units.it/floritaly/index.php>; Martellos et al. 2020). Angiosperm families are arranged according to APG IV (2016). Within families, genera, species and subspecies are listed in alphabetical order. Life forms and chorotypes were attributed according to Pignatti (2017a, 2017b, 2018), not considering casual aliens and cultivated species. We also highlighted those taxa included in the National Red List (Rossi et al. 2013, 2020). Chorotypes were simplified as follows: Eurosiberian,

Eurosiberian-Mediterranean, Mediterranean, wide distribution, Italian endemic, alien. The endemism status was based on Peruzzi et al. (2014, 2015). The complete dataset assembled for the present study is available in Suppl. material 1.

To calculate the expected number of species/subspecies, genera, families, and aliens we followed the approach published by D'Antraccoli et al. (2019), which relied on SAR relationships adjusted by environmental modeling. At the end of the study, the method proposed by D'Antraccoli et al. (2022a) was applied to obtain a final Map of Relative Floristic Ignorance and a Virtual Floristic List of the study area. This allows a proper planning of possible further floristic investigations of the area. In particular, all the floristic records (11,858) available in Peruzzi and Bedini (2013 onwards) for Empoli (6,791, i.e. 57% of the total number of records) and surrounding municipalities (Capraia e Limite, Castelfiorentino, Cerreto Guidi, Montelupo Fiorentino, Montespertoli, San Miniato, Vinci) were used.

Results

The expected number of species/subspecies, genera, families, and alien taxa was 834, 474, 101, and 38, respectively. A total of 757 specific and subspecific taxa were documented for the study area, including 117 aliens. Cultivated plants are 51. These taxa belong to 462 genera and 108 families.

Three families alone cover more than 30% of the total vascular flora (Asteraceae 99 taxa, Fabaceae 77, and Poaceae 71). The most represented genera are *Trifolium* (17 taxa), *Lathyrus* (14 taxa), *Crepis* (9 taxa), and *Allium* (7 taxa).

The biological spectrum highlights that hemicryptophytes (34%) and therophytes (32%) are the most represented life forms, followed by phanerophytes (15%), geophytes (14%), chamaephytes (3%), and hydrophytes (2%). As far as the chorological spectrum is concerned, the most frequent chorotypes are Mediterranean (35%) and Eurosiberian (25%), with 8% of Eurosiberian-Mediterranean taxa. A wider distribution is shown by 17% of taxa, while Italian endemics are only 1%. On the contrary, aliens are 14% of the established flora.

The Italian endemics are seven: *Artemisia caerulea* L. subsp. *cretacea* (Fiori) Brilli-Catt. & Gubellini, *Crocus biflorus* Mill., *Daucus broteroi* Ten., *Ophrys classica* Devillers-Tersch. & Devillers, *Polygala flavescens* DC. subsp. *flavescens*, *P. vulgaris* L. subsp. *valdarnensis* (Fiori) Arrigoni, and *Scabiosa uniseta* Savi.

Further 23 taxa are of phytogeographical interest. Among them, there are species which usually grow at higher elevations, such as *Lilium martagon* L., *Physospermum cornubiense* (L.) DC., and *Scilla bifolia* L., and others that mark their innermost distribution in Tuscany, as *Asphodelus fistulosus* L., *Imperata cylindrica* (L.) Raeusch, *Ophrys speculum* Link, and *Sisymbrium irio* L. (this latter species representing a new record for the province of Firenze). Other species rare in Tuscany and found in the study area are: *Allium pallens* L., *Bolboschoenus glaucus* (Lam.) S.G.Sm., *Butomus umbellatus* L., *Cyperus flavescens* L., *C. michelianus* (L.) Delile, *Lathyrus tuberosus* L., *Lycopus exaltatus* L.f.,

Lythrum tribracteatum Spreng., *Eriolobus florentinus* (Zuccagni) Stapf, *Melampyrum cristatum* L. subsp. *cristatum*, *Onopordum acanthium* L. subsp. *acanthium*, *Rorippa palustris* (L.) Besser, *Securigera cretica* (L.) Lassen, *Spirodela polyrhiza* (L.) Schleid., *Taraxacum noterophilum* Kirschner, Sonck & Štěpánek, *Tripleurospermum inodorum* (L.) Sch.Bip., and *Tulipa sylvestris* L.

The most frequently observed species are: *Plantago lanceolata* L. (117 records), *Daucus carota* L. subsp. *carota* (110), *Trifolium nigrescens* Viv. subsp. *nigrescens* (107), *Cichorium intybus* L. (98), *Dittrichia viscosa* (L.) Greuter subsp. *viscosa* (93), *Acer campestre* L. (73), *Avena barbata* Pott ex Link and *Picris hieracioides* L. subsp. *hieracioides* (72), *Rubus ulmifolius* Schott (69), and *Convolvulus arvensis* L. (64) among natives; *Artemisia verlotiorum* Lamotte (194), *Arundo donax* L. (141), *Robinia pseudoacacia* L. (70), *Sorghum halepense* (L.) Pers. (56), and *Erigeron canadensis* L. (43) among aliens; *Vitis vinifera* L. (97), *Olea europaea* L. subsp. *europaea* (60), *Cupressus sempervirens* L. (47), *Pinus pinea* L. (29), and *Sorghum bicolor* (L.) Moench (21) among cultivated plants.

Among alien taxa, 28 are invasive and some of them are listed in European regulations UE 2016/1141, 2017/1263 and 2019/1262: *Alternanthera philoxeroides* (Mart.) Griseb. and *Ludwigia peploides* (Kunth) P.H.Raven subsp. *montevidensis* (Spreng.) P.H.Raven, both massively occurring along the banks of the Arno river, and *Ailanthus altissima* (Mill.) Swingle.

Eight species recorded by previous authors have not been found, and could be possibly extinct at the local level: *Carex caryophyllea* Latourr., *Epipactis helleborine* (L.) Crantz, *Hippocrepis biflora* Spreng., *Isolepis cernua* (Vahl) Roem. & Schult., *Persicaria amphibibia* (L.) Delarbre, *Pyrus cordata* Desv., *Roemeria hispida* (Lam.) Stace, and *Salvinia natans* (L.) All.

Discussion

With respect to the predicted richness based on species-area relationships, the number of families is just slightly above the expected value, the number of genera is 3% less, while the number of species/subspecies is 10% below the theoretical prediction. This could be explained both by undersampling (see below) or by the scarce environmental variability/high overbuilding of the study area. On the contrary, the number of alien taxa is 207% above the expected value, fully confirming the high human impact on this territory. Indeed, more than 60% of the flora was observed in fields, meadows, olive orchards, and vineyards.

The Virtual Floristic List calculated on all available records for Empoli and surrounding territories includes 789 taxa, of which 619 show a percentage of spatio-temporal probability of occurrence above 95%, while 18 are below the 10% (Suppl. material 2).

The Map of Relative Floristic Ignorance highlights the cells hosting the relictual forest areas as the best known on floristic grounds (Fig. 2). Given that the sampling effort (i.e. number of floristic records) there and in the surrounding areas was comparable, these areas can be effectively interpreted as those hosting the highest species

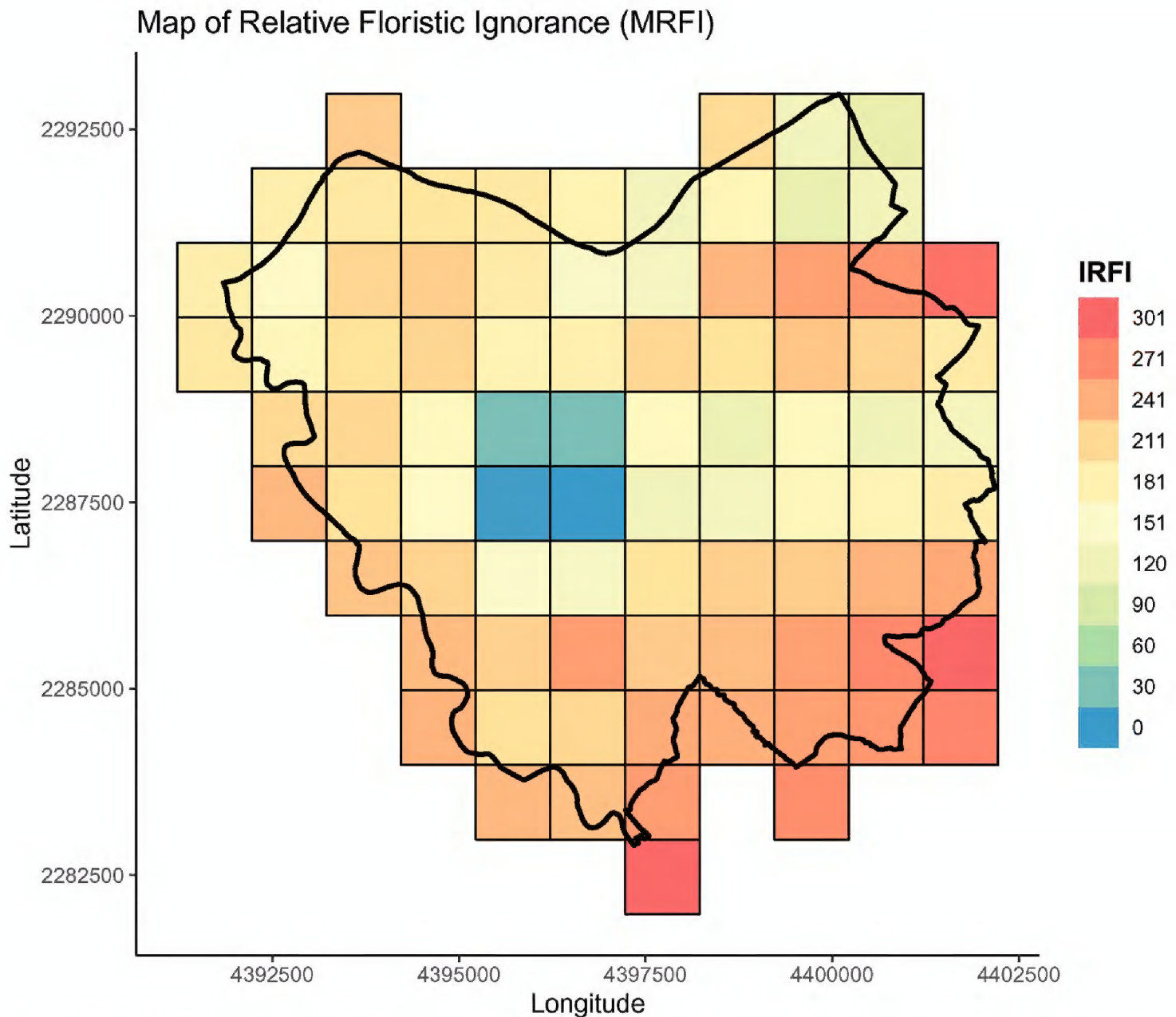


Figure 2. Maps of Relative Floristic Ignorance of the municipality of Empoli, computed with a cellsize = 1000 m and a temporal coefficient $\tau = 20$. The colour scale represents values of Index of Relative Floristic Ignorance (IRFI), ranging from 0 (blue) to a maximum value (red) representing the cells showing lowest and highest relative ignorance, respectively. Coordinates are projected in EPSG 3035: ETRS89/ETRS-LAEA.

richness in Empoli. The cells near the eastern and southern border of the municipality that show the highest relative floristic ignorance, on the contrary, also correspond to areas that are less studied as compared to others. In this case, it is likely that more intensive studies may change the picture, so that these areas cannot safely be interpreted merely as less rich on floristic grounds.

On phytogeographical grounds, the area clearly shows a Mediterranean affinity, while the life forms are more suggestive of a temperate bioclimate. A similar, but opposite, situation was observed in the geographically close hills of Montalbano (Gestri and Peruzzi 2013). There, a phytogeographical Eurosiberian affinity is coupled with life forms more typical of the Mediterranean bioclimate.

The species showing some conservation interest are 42, among which the most important is certainly *Butomus umbellatus*, vulnerable at national level (Rossi et al. 2013). This species is very rare in Tuscany and, outside the province of Firenze, it has been

recently found only in the province of Arezzo (Lastrucci and Raffaelli 2006). Moreover this species grows, together with other native taxa, such as *Lysimachia vulgaris* L. and *Schoenoplectus tabernaemontani* (C.C.Gmel.) Palla, along the banks of the Arno river, i.e. exactly in the area most impacted by invasive aliens. The abundance of aliens in riparian habitats is well known also for other areas in Tuscany (Bonari et al. 2021).

The relictual forest areas still occurring in Empoli are of special conservation interest. Indeed, in these small areas, more than half of the plants known for the studied territory are found, including interesting species such as *Barlia robertiana* (Loisel.) Greuter, *Eriolobus florentinus*, *Galanthus nivalis* L., *Hypericum australe* Ten., *Lilium martagon*, *Melampyrum cristatum* subsp. *cristatum*, *Physospermum cornubiense*, *Polygala flavescens* subsp. *flavescens*, and *Polygala vulgaris* subsp. *valdarnesis*.

Finally, concerning aliens, based on their occurrence in this flora, the regional alien status for Tuscany of *Azolla filiculoides* Lam., *Prunus cerasifera* Ehrh., and *Veronica filiformis* Sm. should be changed from casual (Galasso et al. 2018; Lastrucci et al. 2019) to naturalized. The impressive amount of aliens (14%) is comparable to that found in large Italian urban areas such as Roma (Celesti-Grapow et al. 2013; ca. 14%), Palermo (Domina et al. 2020; 16%), or the historical centre of Bologna (Salinitro et al. 2018; 30%).

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Supplementary material 1

Floristic list and records

Authors: Lorenzo Peruzzi

Data type: PDF file

Explanation note: 1. Floristic list and records. 2. References cited only in the supplementary materials.

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Supplementary material 2

Virtual floristic list

Authors: Lorenzo Peruzzi

Data type: Excel .xlsx file

Explanation note: Virtual Floristic List, elaborated according to D'Antraccoli (2022a).

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